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**INFLOWS AND THE RESTORATION OF THE SALTON SEA**

**By**

**Kevin P. Janik**

**B.A. University of Colorado, Boulder 1996**

**presented in partial fulfillment of the requirements**

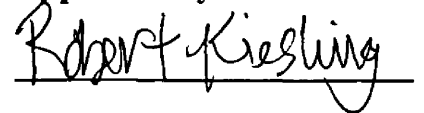
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**Approved by:**

  
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**Chairperson**

  
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**Dean, Graduate School**

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Inflows and the Restoration of the Salton Sea

Chairperson: Bob Kiesling 

This paper examined how current and future inflows into the Salton Sea affect the possibility of its restoration. The purpose of this paper is to analyze some of the important issues that pertain to the Sea and from that analysis determine the best course of action for implementing a restoration plan. The health of the Salton Sea has been declining for decades and many scientists and organizations have recognized that the ecological collapse of the sea is imminent unless restoration efforts commence immediately. The Salton Sea is a terminal body of water located in a desert ecosystem that has only three major inflows. I analyzed water quality data and flow data from the New, Alamo and Whitewater rivers to demonstrate the major areas of concern with regards to the restoration process. This information was applied to the parameters of the Salton Sea Authority's proposed restoration plan to evaluate the potential of its effectiveness.

In addition to the analysis of the rivers I addressed the effects that the inflows have on wildlife, recreation, economics, agriculture, air quality and public health. I demonstrated the importance that maintaining and managing the inflows has on all of these issues. The inflows into this unique and valuable body of water are the paramount issue to examine when attempting to improve the ecological health of the Sea.

Another topic that I focused on is the legislation that has affected the inflows and restoration efforts up to this point. Often times in the arid West water law can dictate the outcome of any water related issue or project. Taking a look at the laws that are on the books and laws that are being proposed for the inflows will be a very important part of developing an appropriate restoration plan for the Sea.

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## **Background Information**

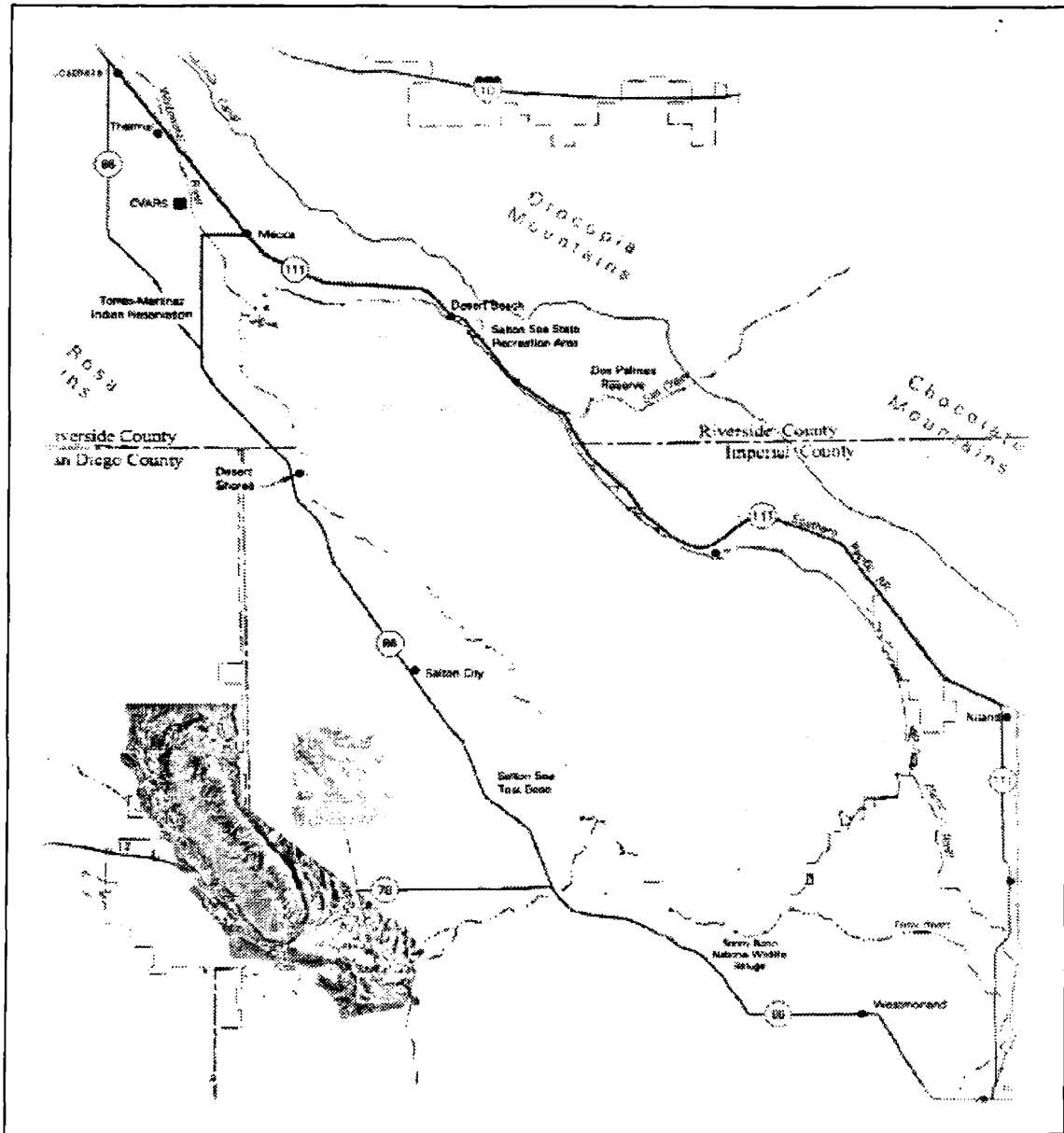
The Salton Sea is a unique place that raises some complex issues. There are a lot of organizations, agencies and people that are involved in the issues surrounding the Sea. The purpose of this paper is to analyze some of these issues and then by using the information that I have presented determine the best way to implement a restoration plan for the Sea. The health of the Sea has been in decline for decades and ecological collapse is imminent. The information that I will present will demonstrate why it is important to act immediately. I will finish the paper by reviewing a restoration plan that will address the issues that I have identified.

Located in the southeast corner of California the Salton Sea is the state's largest inland body of water (See Figure 1). The Sea covers 376 square miles and its current surface level is 227 feet below sea level. This enormous, wetland ecosystem is approximately 35 miles long and 15 miles wide. The Sea's average depth is 29.9 feet with a maximum depth of 51 feet. The total volume of water in the Sea is estimated to be about 7.5 million acre-feet. The Sea is in the Colorado Desert, an area that typically only gets three to four inches of rainfall annually. This unique location can experience temperatures in excess of 120 degrees in the summer and occasionally drop below freezing for short periods of time in the winter. In the summer, water temperatures in the Sea can reach 90 degrees. The location and climate of the Sea contributes to the complexity of problems that it is facing.

The Sea occupies the lowest portion of a geographic feature known as the Salton Trough. The northwest section of the trough is located in the Coachella Valley and the southeast section of the trough is located in the Imperial Valley. The Sea is located in a

**Figure 1**

**Source: Tetra Tech Inc.**



**Salton Sea Location Map**

seismically active area with the San Andreas Fault line passing only a few miles from its shores (Corona N.d.). The Sea is in a beautiful setting that is surrounded by a number of different mountain ranges. The basin is bordered by the San Jacinto and Santa Rosa mountains to the west, the Orocopia Mountains to the north and the Chocolate Mountains to the east. The geography of the area provides breathtaking vistas as mountain peaks like San Jacinto rise from the desert floor to over 11,000 feet.

There is nothing typical about the Sea. Its creation and existence are extremely unique. Throughout geologic time the Salton Trough has filled up with water and then been allowed to dry up again as the mighty Colorado River meandered through the landscape. In the past when the basin was filled it created what was called Lake Cahuilla. Geologists determined that this ancient and intermittent lake extended as far south as Mexico merging with the Gulf of California (Buckles 2002). In fact, from 1828 to 1904, Colorado River flows flooded the Salton Basin no fewer than eight times (SSA 2005).

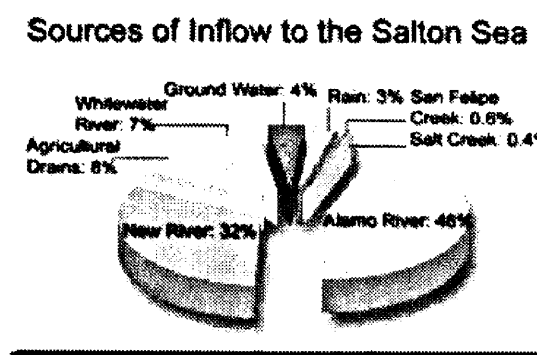
In the early 1900's settlers were looking for a way to bring the abundant flows of the Colorado to the fertile lands in the Imperial Valley for agricultural purposes. The formation of the modern day Salton Sea was the result of Mother Nature and a botched engineering project. In 1905 large flows from the Gila River in Arizona combined with the Colorado River during a major flood event. The combined flows breached a main levee that was part of an early Imperial Valley irrigation system. This breach allowed the majority of the Colorado River's flow to pour into the Salton Basin for approximately a year and a half. Not until the Southern Pacific Railroad constructed a trestle completely across the breach and poured tons of boulders into the break was the river redirected away from the Salton Basin (Kennan 1917).

This time around the Sea had a different fate. The Sea was not allowed to wither away in the relentless desert sun. As early as 1928 the federal government designated the Sea as a drainage basin for the booming agricultural industries of the Coachella and Imperial valleys. Therefore, the arid floor of the Salton Trough was not re-exposed. The Sea was kept full with irrigation runoff water. The agriculture industry irrigates all of its crops with Colorado River water and the runoff from irrigation provides the inflows to the Sea. The inflows to the Sea increased as the agriculture industry grew. To this day almost the entire inflow to the Sea (90%) is from agricultural runoff, which is transported to the Sea via rivers, creeks, agricultural drains and groundwater infiltration (SSA 2005). Colorado River water is what sustains the agriculture industry and the inflows to the Sea.

The Sea's surface level has remained constant in recent years because the average annual inflow to the Sea, 1.36 million acre-feet, is equal to the amount of water that evaporates from the Sea every year (IID 2005a). Due to the fact that the Sea is a terminal body of water, evaporation is the only outlet for water from the Sea. This fact makes it critical to manage the inflows to the Sea. The amount and quality of the water that flows into the Sea is crucial to its ecological health. Later in this paper I will examine the flow rates and certain water quality parameters of the main sources of inflow into the Sea. I will look at the Whitewater, New and Alamo rivers as they make up 85% of the total flow into the Sea (See Figure.2).

**Figure 2**

**Source: Salton Sea Authority**



As the name implies, salinity in the Salton Sea is a major concern. A combination of natural salts that occur in Colorado River water and salts that are leached from large-scale, industrial, mono-crop, agricultural fields create an enormous salt load on the Sea. High evaporation rates in the Sea's desert ecosystem remove large amounts of water while leaving salts behind. Based on its volume at a surface elevation of negative 227 feet and an annual salt inflow of 4 million tons, the Sea's salinity is estimated to be rising at approximately 0.4 parts per thousand per year from its current value of about 46 parts per thousand (SSSS 1998). The current salinity of the Sea is about 25% saltier than the Pacific Ocean and it is rising everyday. The large amounts of salt in the water have the potential to create massive fish die-offs that adversely affect birds and other wildlife in the area. . These drastic numbers are the reason that restoration efforts must commence immediately. The Salton Sea Authority's restoration plan that will be evaluated later in this paper will restore the Sea to a level consistent with a healthy marine environment.

Another important resource at the Sea that will be affected by inflow management is recreation. The Salton Sea has tremendous potential for a multitude of recreational opportunities. Before the decline of the Sea's health, in the sixties and early seventies, the

Salton Sea State Park had more visitor days per year than Yosemite National Park (SSA 2005). There are over two thousand campsites at various locations around the Sea. Many of the camping areas include picnic tables, barbeques, RV hookups and boat ramps. The potential for sport fishing at the Sea is phenomenal. Studies conducted at the Sea in the late eighties proved that the Sea is one of the most productive fisheries in the world (CIC 1989). The abundance of fish attracts millions of birds to the Sea every year. This makes attractions like the Sonny Bonno Salton Sea National Wildlife Refuge, located at the south end of the Sea, a popular destination for bird watchers. The geographic beauty, abundant wildlife and productive fisheries of the Sea could provide a welcome economic boost for the now struggling area.

Agriculture and the Sea are closely tied together. The Sea relies on inflows from agricultural drainage and the agricultural industry relies on the Sea as a drainage repository for its runoff. The environmental and economic impact that agriculture has on the area is substantial. Agricultural fields dominate the surrounding landscape. The fields provide hundreds of thousands of acres of habitat for birds and small animals. Fertile soils, consistent water supplies and a favorable year round climates make the Imperial and Coachella valleys some of the most productive agricultural regions in the world. In 2004, Imperial County farms utilized some 502,000 irrigated acres of farmland to produce crops valuing nearly 1.5 billion dollars (IID 2005b). In the same year Coachella Valley farms utilized 80,000 irrigated acres to produce crops valued at 557 million dollars (CVWD 2005). This two billion dollar per year industry dominates the landscape and the culture of the Salton Sea Basin. The agriculture industry is booming but the distribution of wealth is anything but equal. Farm workers are some of the lowest paid

laborers in California. Nearly all of the profit goes to the leaders of the large agribusinesses that control the industry. Farm workers and elderly people living on fixed incomes make up a large portion of the surrounding communities.

Not only is the Sea directly reliant upon the agriculture industry but many of the local residents are as well. The Coachella Valley has approximately 10% of its residents employed in the agricultural industry while Imperial County can have as many as 45% of its residents relying on agriculture for employment (SSA 2005). The percentage of Colorado River water that is dedicated to agriculture has a direct effect on the economy of the area and the ecological health of the Sea. If this precious water resource is diverted to municipalities near the coast of California the Salton Sea and its surrounding communities will be affected in more ways than one.

The Salton Sea is a special body of water that has a wide range of complex problems. Certain parameters need to be set for the Sea's restoration. In most cases the goal of ecological restoration is to restore an ecosystem to its natural state, that is, the state that it was in before the actions of man altered it. This is not the goal of the Salton Sea restoration plan. This is due to the fact that the Sea's natural state or existence was intermittent. Part of the restoration goal is to have it remain as a repository for agricultural runoff. This use of the Sea was mandated by an executive order from the federal government. This fact alone makes it impossible to return the Sea to its natural state. The goal is to restore it to the condition it was in during the fifties and sixties. At that time the ecological health of the Sea was similar to a healthy marine environment. The desired outcome is a Sea that can support healthy populations of fish and birds while providing a pleasant recreational opportunity for people. Another component of the

restoration plan that is directly related to inflow is preserving current shoreline levels. This aspect of the plan is critical to eliminate the possibility of fugitive dust problems that will occur when fine seabed sediments are exposed due to reduced inflows.

## **Wildlife**

The amount of wildlife that the Salton Sea ecosystem supports is remarkable. The habitat that the Salton Sea basin provides for mammals, reptiles, amphibians, birds and fish is some of the last habitat of its kind in California and North America in general. Developers have claimed 91% of California's wetlands thus far, highlighting the importance of protecting and restoring what little wetland habitat we have left. If the issues surrounding the Sea's restoration are pushed aside we will be even closer to eliminating all of California's wetland ecosystems. By eliminating this precious habitat we will also be eliminating the wildlife that depends on it.

One of the reasons that the Salton Basin can provide a home to such a diverse array of species is that it encompasses a broad set of ecosystem types. Traveling a short distance within the Salton Basin and its surrounding areas one will find ecosystems ranging from high alpine to lower Sonoran desert. Throughout different parts of the year wildlife will traverse through and utilize these various ecosystems. It may be an endangered bighorn sheep coming down from the mountains looking for water in the summer or a migratory bird stopping over in the winter months to take advantage of the warm desert climate. Along with the variety of regional ecosystems, the habitats in direct proximity to the Sea vary as well. Habitat types within or immediately adjacent to the Sea include freshwater marsh, salt lake, desert, palm oasis and agricultural fields. The



diversity of habitats within the Salton Basin creates an environment that is able to sustain high levels of biodiversity.

The main focus of this section will be on birds and fish. However, I think it is important to mention other types of wildlife as well. The Sea is home to 24 types of reptiles and over 20 mammals, with most of these species being found in desert and wetland areas (SSA 2005). Some of the mammals include a variety of bat and mice species, coyote, deer, bobcats and the endangered bighorn sheep. Species of snakes include the Colorado Desert sidewinder and the arboreal coachwhip that hunts for eggs and birds. Other species of concern are the federally threatened Coachella Valley fringed toed lizard and the desert tortoise. These unique species have been the focus of many scientific studies and conservation efforts. The valuable wildlife diversity of this area was recognized as early as 1930 by president Herbert Hoover's presidential proclamation to designate the south end of the Sea as a wildlife refuge. In more recent years the refuge has been renamed the Sonny Bono Salton Sea National Wildlife Refuge.

The Salton Sea is a major stopover point along the Pacific Flyway. The flyway is the path that migratory birds follow from tropical regions in Central and South America all the way to the northern most regions of North America. Due to the loss of California's wetlands the Salton Sea has become an increasingly more important habitat for these birds. The Sea has become known as North America's "crown jewel of avian biodiversity" hosting over 400 different species of birds comprising millions of avian visitors annually (Audubon Society 2005). What is more impressive and ecologically more important than the species diversity is the large number of birds using the Salton Sea and adjacent habitats year round (Cooper 2004). An internationally significant

stopover site for hundreds of thousands of transients moving north and south along the Pacific Flyway, and east into the Great Basin/Prairie Pothole Region, the Sea is also the winter home for hundreds of thousands of individuals of numerous species from around North America (Cooper 2004). Among these numerous species at least twenty-five of them are listed as sensitive or endangered under the federal endangered species act. The endangered species found at the Sea include the Yuma clapper rail, which is known to successfully breed at the Sea, the California brown pelican, southern bald eagle and the peregrine falcon (USFW 2005). Some of the sensitive species found at the Sea are the fulvous whistling duck, wood stork, long-billed curlew, mountain plover, western snowy plover, burrowing owl and the white faced ibis (USFW 2005).

A major issue that raised international concern over the ecological health of the Sea was the outbreak of various diseases that contributed to massive bird die-offs in the 1990s. Particularly hard hit in the 1990s were the eared grebe (150,000 in 1992, unknown causes); American white pelican (9,000 in 1996, botulism); brown pelican (1,200 1996, botulism); and a combination of various waterfowl, shorebirds and waders (>11,000 in 1998, avian cholera) (RWQCB 2003). Most of these cases were not directly related to water quality but were simply accounted for as a result of very large population sizes. Disease spreads more readily through large populations of fish and birds living in close quarters. Specific, direct causes of these outbreaks, and even the types of disease affecting some of these birds, is largely a mystery and will be the topic of additional scientific study.

Although evidence is not conclusive, discussions I had with Jack Crayon, a biologist for the California Dept. of Fish and Game, indicated that stresses on saltwater

fish from poor water quality might make them more susceptible to botulism. Eating sick fish could infect fish-eating birds, like the pelicans that were killed in the 1990s. These kinds of situations demonstrate the complexity of the problems that scientists are trying to address at the Salton Sea.

One of the reasons that there is such a wide variety and multitude of birds at the Sea is because of the large numbers of fish that live in the Sea. Starting in the 1950s, to promote sport fishing, the Sea was stocked with fish that are native to the Gulf of California like croaker, corvina and sargo (Kaiser 1999). The most abundant and only remaining freshwater fish, the African tilapia, was originally released in the canals that supply water to the Sea to eat weeds (Kaiser 1999). The tilapia were originally raised in fish farms but they have proven to be extremely successful at reproducing in the Sea's saline waters. All of the fish that live in the Sea were introduced with the exception of the endangered desert pupfish (Sutton 2002).

The productivity of the Sea's aquatic ecosystem is due in large part to the nutrient rich inflows that fill the Sea from the surrounding agricultural fields. Nutrient rich water produces algae and phytoplankton that provide food for pile worms and zooplankton. The zooplankton and pile worms provide an abundant food source for the fish allowing their populations to climb into the millions. While the nutrient rich waters can be a catalyst for the thriving fish species they can also lead towards their demise. This fact demonstrates the importance of managing the inflows to the Sea. The Sea's delicate ecosystem needs to remain balanced and it is currently becoming unbalanced as nutrient levels are rising. Decomposition of large algal blooms creates extremely oxygen deficient waters that fish cannot survive in. This harmful decomposition process can also produce layers of water

high in ammonia and hydrogen sulfide that act like poison to fish. When hyper-eutrophic conditions exist in a relatively shallow body of water like the Sea, strong desert winds can mix the previously stratified layers exposing fish to poisons and deoxygenated waters. The results can be catastrophic. On August 4<sup>th</sup>, 1999 an estimated 7.6 million fish died in one day (Vessey 2002). The Sea has experienced many smaller but significant fish die-offs numbering in the thousands throughout the years. Scientists attribute the die-offs to the hyper-eutrophic conditions created by nutrient rich inflows (Holdren 2000).

## **Air Quality/Public Health**

The previous section demonstrates the enormous value and scale of the wildlife that is sustained by the Salton Sea ecosystem. In my opinion that alone is reason enough to restore and maintain the integrity of the Sea. However, it can be difficult to get the public behind such a fight. Most people are far removed from the Sea itself and the wildlife issues just turn into statistics on paper. What might raise more concern and debate is the issue of public health. Proposed water transfers that will diminish inflows to the Sea will expose seabed sediments that will become a major source of air pollution. If the public realizes that their own health and the health of their children are at risk, it just might get them more involved.

The possibility of seabed sediments contributing to air pollution is not merely speculation. This very situation has occurred before when other terminal, saltwater lakes have been drained in California. I will take a look at the situations that have occurred in Mono and Owens lakes near the Eastern Sierras in California. Federal PM-10 standards

have been drastically violated in these areas as a result of the inflows of these lakes being diverted for municipal water use in Los Angeles.

First I would like to discuss what the federal PM-10 standard is and why it is important. The PM-10 standard refers to very fine dust particles that have a diameter of 10 microns or less that contribute to air pollution. The EPA has set this federal standard to control concentrations of these particles within the different airsheds in our country. The standard was developed through the evaluation of many human health risk studies and is based on potential negative impacts to human health. These tiny particles are dangerous because they can get into the lower respiratory tracts of humans. This can cause asthma attacks and make it difficult for people to breath. Children, the elderly and people with respiratory problems can be especially sensitive to these particles. When the standard is tested scientists measure the number of micrograms of dust there are in a cubic meter of air as a 24-hour average. The federal standard is set at 150 micrograms per cubic meter. The state of California has even more stringent air quality standards; in certain counties it is as low as 50 micrograms per cubic meter. Riverside and Imperial counties, where the Salton Sea is located, are all ready considered non-attainment areas because they are currently exceeding the standard.

The following information about Owens and Mono lakes is synthesized from the testimony of Theodore D. Schade at the California State Water Resources Control Board hearing regarding the Salton Sea in 2002. Mr. Schade is the Senior Project Manager of the Great Basin Air Pollution Control District. He has been studying dust emissions at Owens and Mono lakes for the past 15 years and is also a registered professional civil engineer.

Owens Lake, located near the foothills of the Eastern Sierras of California, is very similar to the Salton Sea. It is a terminal, saltwater lake where evaporation serves as the only outlet for water. The fate of Owens Lake was sealed when construction of the Los Angeles aqueduct was completed in 1913. This engineering project diverted inflows that previously sustained the lake. Essentially the lake was drained, exposing 60 square miles of the lakebed. As a result, the largest dust storms ever recorded in the U.S. were recorded at Owens Lake (Reheis N.d.). Emissive surfaces formed on Owens Lake make it the largest single source of particulate air pollution in the country (Schade 2002). The problems are so profound because Owens Lake is a relatively young dry lake. It is possible for conditions to stabilize but that might take hundreds of years. The total cost for mitigation measures on the worst 30 miles is estimated at \$415 million initially with an additional \$26 million annually to keep the lake damp (Bourne 2005). Some of the mitigation efforts include shallow flooding, managed vegetation and gravel blankets.

Some slightly encouraging news is that in 1994 the California Water Board denied the city of Los Angeles the ability to divert additional water from Mono Lake in California's Eastern Sierra's. The city has been diverting water from Mono Lake since 1940. These diversions also created huge dust storms in the area that were exceeding the PM-10 standards. The Water Board realized that the only way to comply with the federal and state air quality standards was to raise the lake's surface level elevation to cover emissive lakebed sediments. Through extensive air quality monitoring efforts it was determined that the air quality was improving as the surface level was raised. The severity of the dust storms has decreased and scientists monitoring the situation are

hopeful that they will be in compliance with state and federal standards when the target surface level elevation is met.

The situation at the Salton Sea could be more drastic than the situations I have described at Owens and Mono lakes. In 2003 legislation was passed that will decrease the inflows of the Salton Sea. The Quantitative Settlement Agreement (QSA) allows for the transfer of Colorado River water to municipalities in San Diego and elsewhere. Very conservative estimates of the water transfer schedule show that at least 300,000 acre-feet of inflows will be lost. This will expose an estimated 78 square miles of seabed. That is over twice the size of the area exposed at Owens Lake (GBAPCD 1998). When I say a conservative estimate, I mean, really conservative. The California Department of Water Resources is entertaining restoration plans for the Sea that would decrease inflows by 800,000 acre-feet per year. It gets worse. The QSA has stipulations in it that would allow for transfers of up to 1.6 million acre-feet per year.

The seriousness of these impacts are not being adequately addressed by the state or the Imperial Irrigation District. Mr. Schade has major problems with the environmental impact report that the Imperial Irrigation District has produced for the water transfer project. The report downplays the potential effects that the exposed shoreline will have on air quality. They have done no modeling and only offer qualitative accounts of potential effects. And of course, they are using the conservative water transfer estimates of 300,000 acre-feet per year. Mr. Schade and other prominent scientists in the field say the report is simply incorrect. Even using the bad science and conservative numbers in the irrigation district's report it can be extrapolated that the water transfers would result in conditions that greatly exceed PM-10 standards.

Another point of concern is the difference in the makeup of the sediments found at the Salton Sea versus the ones that were found at Owens and Mono lakes. Owens and Mono lakes were not designated as repositories for agricultural runoff. While the water in the Salton Sea does not contain high levels of residual toxic components from pesticides, some of these materials can be found in the sediments. Chemicals found in Salton Sea sediments at elevated concentrations and of potential ecological concern are cadmium, copper, molybdenum, nickel, zinc and selenium (Vogl 2002). These sediments do contain toxic materials including pesticides and uranium (LFR Levine & Fricke 1999). It is still unclear if the concentrations of these sediments will be high enough to cause additional health risks when they become airborne. However, even without additional scientific study and modeling, I think most people would agree that this is a point of major concern.

Mr. Schade and the people I referenced above are not the only people concerned about this issue. In April of 2002 the Salton Sea Authority and the U.S. Bureau of Reclamation convened a panel of twelve air quality experts who had concerns surrounding these issues. They all agreed that without mitigation the water transfers would cause serious air quality concerns for the region. They also agreed that current studies on the subject conducted by the Imperial Irrigation District have been inaccurate or simply false and that extensive modeling should be performed (Schade 2002). Larry Biland with the U.S. Environmental Protection Agency stated that, "This was the best and brightest group of experts that I have ever seen come together to address issues of dust associated with dry lakes."

## **Legislation**



To understand the issues that concern the inflows and the potential to restore the Salton Sea it is important to examine the legislation that is already on the books; not only the legislation that is directly related to the Sea but also the legislation that affects water transfers and allotments in the West. Many of these laws have to do with the allocation of Colorado River water. Colorado River water that has been diverted for agriculture contributes to the vast majority of the Sea's inflows so the laws concerning the water in the river directly affect the Sea. In this section I will discuss key legislation that has led us to the current situation with the Sea. Finally, I will examine the most recent legislation that is going to affect the Sea's future and ultimately decide its fate.

Legislation regarding the Sea started in the first part of the twentieth century. An executive order of withdrawal from President Coolidge, (Public Water Reserve No. 114, California No. 26), was signed in 1928. This order designated the Sea as a repository for agricultural wastewater from the Imperial Valley. The law was intended to help protect the wintering habitat for waterfowl and migratory birds. Early on the Sea was determined to be an important area for wildlife. In 1930 President Herbert Hoover's presidential proclamation established the Salton Sea National Wildlife Refuge. The name was changed in 1998 to honor Sonny Bono. The refuge still exists today and is known as the Sonny Bono Salton Sea National Wildlife Refuge and Complex. It is interesting to see that these laws highlighted the importance of the areas biodiversity nearly one hundred years ago.

Over the past century many federal laws, court decisions, contracts and decrees have served to regulate the distribution of Colorado River water. When combined, these laws create what is known as the "Law of the River". Now I will take a look at some of

the more important decisions to demonstrate how we have come to our current situation regarding Colorado River water and the Salton Sea.

One of the earliest and most defining pieces of legislation concerning the river was the Colorado River Compact that was signed in 1922. The compact divided the water between the states located in the Colorado River Basin. The upper basin states include Wyoming, Colorado, Utah and New Mexico while the lower basin states include Arizona, Nevada and California. The compact declared that the upper and lower basins each got 7.5 million acre-feet of water annually.

The Boulder Canyon Project Act of 1928 further apportioned the 7.5 million acre-feet of water between the lower basin states. California received the lions share at 4.4 million acre-feet annually with Arizona coming next at 2.8 million acre-feet and Nevada bringing up the rear with a measly 0.3 million acre-feet. Nevada's share only represents 4% of the river's entire flow. This fact is causing substantial problems regarding the population boom that Las Vegas has been experiencing in the last decade. In addition the 1928 act authorized the construction of the Hoover Dam and additional irrigation infrastructure in the lower basin. It also designated the Secretary of the Interior as the sole water contracting authority in the lower basin.

The California Seven Party Agreement of 1931 highlights negotiations and conflicts that still exist today between agricultural and municipal interests for river water. This agreement laid out a deal between the seven water districts in the lower Colorado region of Southern California. As we will see, crucial legislation that was recently passed involved very similar conflicts with the same players. The Imperial Irrigation District, Coachella Valley Water District and the Metropolitan Water District were among the

parties involved in 1931 and they are involved in similar negotiations today. Water transfer agreements between these entities allowed the Sea to exist in the past and are now threatening its existence in the future as agricultural water is being transferred to municipalities. There is a long history of conflict and negotiation between these organizations.

We must not forget Mexico. The Mexican Water Treaty of 1944 allotted 1.5 million acre-feet annually to our friends south of the border. Deteriorating water quality was a concern in the past as well. The Salton Sea is very close to Mexico and both are at the end of the line as far as the Colorado River is concerned. Authorities realized that the natural salts in the river combined with additional salts from agricultural activities were creating problems for the river's downstream users. This problem was addressed in 1973 when stipulations to the Mexican Treaty were created to work on reducing the salinity of the water that was being delivered to Mexico.

The Upper Colorado Basin Compact of 1948 created the Upper Colorado River Commission. It also divided the upper basin state's 7.5 million acre-feet allotment. Colorado received 51.75% of the 7.5 million acre-feet, New Mexico got 11.25%, Utah got 23% and Wyoming received 14%. A small portion of Arizona that lies within the upper basin received an additional 50,000 acre-feet annually.

There was a spree of dam construction projects in the 1950's as the country tried to assuage its ever-increasing appetite for energy. The Colorado River Storage Project of 1956 allowed for the construction of the Glen Canyon, Flaming Gorge, Navajo and Curecanti dams. This upper basin water resources development plan was an enormous

effort to regulate water and generate power. As a result, the Colorado's natural meandering course was severely altered.

The Colorado River Basin Project Act of 1968 authorized numerous water development projects in the upper and lower basin, the most substantial of which was the Central Arizona Project or CAP. The CAP project included the construction of a huge aqueduct that would carry water from the Colorado River towards Phoenix. This enormous project would allow Arizona to take advantage of its full river allotment. However, this act gave California priority to assume their entire allotment in dry years before any water would go the CAP. This ruling has proven to be quite burdensome for Arizona in recent drought years.

As I have mentioned before the salinity of Colorado River water has been a concern for some time. This prompted the Colorado River Basin Control Act of 1974. This act included various projects related to improving water quality in the river. Projects like the Yuma Desalting Plant focused specifically on reducing salinity.

Many other laws are included in the "Law of the River" and new legislation is constantly being negotiated as populations rise and water demands increase. Other types of laws influencing this enormous water source include conditions for reservoir and dam releases as well as stipulations regarding Native American water rights. Certain parameters of the Endangered Species Act can also effect the distribution of Colorado River water. Now that the historical stage has been set for Colorado River law I will address more recent legislation that affects the river and the Salton Sea.

In June of 1993 the Salton Sea Authority (SSA) was created by the State of California. The SSA is a Joint Powers Authority chartered by the State for the purposes

of ensuring beneficial uses of the Sea. The organizations that are represented by this Joint Powers Authority are the Coachella Valley Water District, Imperial Irrigation District, Riverside County, Imperial County and the Torres Martinez Desert Cahuilla Indians. The Salton Sea Authority is the lead agency that works with state and federal agencies and Mexico regarding the remediation and restoration of the Salton Sea. The Authorities staff and board members have been the driving force behind collecting and compiling the results of scientific studies and reviewing all remediation and restoration plans and pilot projects. The Salton Sea Authority has developed the leading preferred restoration plan for the Sea with the help and consultation of many public agencies, universities and private companies. I will review the Authority's restoration plan and demonstrate why it should be adopted in a later section of this paper.

The federal government's Salton Sea Reclamation Act of 1998 was created when congress enacted Public Law 105-372. This act authorized the Secretary of the Interior to complete studies that would evaluate the feasibility of options that would allow for: the Sea to continue to act as a reservoir for agricultural drainage, reduction and stabilization of salinity, stabilization of the surface elevation, the protection of resources to maintain healthy fish and wildlife populations and enhanced potential for recreational uses and economic development of the Sea. This act has been the catalyst for much scientific research and has set some necessary parameters for proposed restoration plans. The federal governments recognition of the need to restore the Sea was a big win for restoration advocates.

The culminating piece of legislation for the Colorado River and the Salton Sea is the Quantification Settlement Agreement (QSA) that was reached in 2003. One of the

main reasons for the QSA was to try and get California to reduce its use of Colorado River water. For decades California has been exceeding its 4.4 million acre-feet per year allotment by anywhere from 800,000 to 1.1 million acre-feet annually. California is at the end of the line as far as the other basin states are concerned and it was able to use all of the surplus waters that the other states had not been using. Not only has California been using it, they have become dependent on it. In recent years the combination of population growth and drought have made the other states use their full allotments. In 2003 planners in the Phoenix metro area issued a record-breaking 48,000 new home permits to developers (Jenkins 2005a). In 2004 they issued an additional 60,000 new home permits (Jenkins 2005a). In 2001 alone, the city of Las Vegas added 90,000 new residents to their metropolis (Jenkins 2005b). With statistics like these it is not surprising that the river water is in such high demand.

The QSA is a package of legislation that is contained in four bills: SB 277 (Ducheny), SB 317 (Kuehl), SB 654 (Machado) and SB 1214 (Kuehl). A lot of the focus of these bills is on water transfers between different Southern California agencies, not unlike the California Seven Party Agreement of 1931. Once again, water that was being used to irrigate crops is now being transferred to municipalities. This means that water will be leaving the Imperial Valley causing the inflows to the Salton Sea to decrease. Specifically, the Imperial Irrigation District will be transferring water to the Coachella Valley Water District to alleviate their dependence on groundwater and to the Metropolitan Water District and San Diego County Water Authority to serve their growing human populations. Although the water transfers won't happen all at once, they will be substantial. The legislation tasks the Department of Water Resources to purchase

up to 1.6 million acre-feet of water from the Imperial Irrigation District to be sold to the Metropolitan Water District and others.

Potential negative affects on the Salton Sea were not ignored by the legislation. The legislation was developed to acknowledge the connection between the water transfers and the health of the Sea. As a result the state of California has been put in charge of the restoration measures for the Sea. The State also now accepts sole responsibility and is liable for problems at the Sea that are associated with the water transfers. By the State accepting this responsibility the Imperial Irrigation District is now not liable for any negative impacts that the water transfers have on the Sea. The legislation specifies that the State, acting through the Department of Water Resources, is to develop a preferred restoration alternative for the Sea by the end of 2006. One of the plans that the State is entertaining is the plan created by the Salton Sea Authority and another one is called the "Evolving Sea Plan" which requires no immediate actions. The decision is still out and the way that the state handles it will be critical to the existence of the Sea. A later section in this paper will address this issue in more depth.

Another outcome of the QSA is that the California Dept. of Fish and Game is the chair of a new Joint Powers Authority of local agencies. These agencies include the Imperial Irrigation District, the Coachella Valley Water District, the Metropolitan Water District and the San Diego County Water Authority. This Joint Powers Authority will generate and control approximately \$200 million for mitigation measures from impacts of the QSA on the Sea. The State will pay for mitigation measures in excess of that amount. In addition to this money the QSA has also generated funds of up to \$300 million from

the sale of water to be put in an account dedicated to the restoration of the Sea. Currently, the state controls this money.

In addition to giving the State control of the restoration process and mandating water transfers between the involved agencies the QSA calls for various water conservation measures. A major conservation project is the lining of portions of the All American Canal, which is the areas largest aqueduct. There is also the possibility of land fallowing to reduce water usage. All of the proposed conserved water has a destination, unfortunately it does not look like it will be to the Salton Sea. I will discuss the implications of the QSA in greater detail in a later section.

## **Water Quality and Flow Data**

This section will examine water quality and flow data from the New, Alamo and Whitewater rivers. Water quality and flow data were obtained from monitoring sites located at the rivers' outlets to the Sea. It should be noted that this data and data taken directly from the Sea at various depths could be very different. For example, dissolved oxygen levels for Whitewater River water may be 7.5 mg/l which is considered healthy, however, dissolved oxygen levels measured on the same day from a depth of 40 ft. in the middle of the Sea may be 2.5 mg/l which supports almost no aquatic life. All of the chemical inputs to the Sea accumulate because it is a terminal body of water. The chemical reactions that take place in the Sea are extremely complex. The goal of analyzing this data is to examine the chemical make-up of the water that sustains the Sea. The amount and quality of the inflows to the Sea ultimately determine the health of the



Sea. This data will identify the source of some of the problems that are found in the Sea. Tables containing water quality and flow data are located at the end of this section.

The last year of complete flow data for the major inflows to the Sea is 2004. Total inflows into the Sea for 2004 were right around 1,240,000 acre-feet. This is consistent with the approximately 1.3 million acre-feet per year that has been sustaining the Sea for decades. The breakdown for the inflows is consistent with historical records as well. The Alamo River accounts for 46% of total inflows, the New River is 32%, the Whitewater River is 7%, various agricultural drains are 8%, groundwater is 4% and rain accounts for the remaining 3% of the inflows. This is very good news for the Sea. The water transfers mandated by the QSA have not been implemented yet. Flow rates will decline when the water transfers begin. This will expose fine seabed sediments to wind, accelerate rising salinity levels and exacerbate biological and physical stressors on aquatic species. Dedicating between 700,000 and 800,000 acre-feet a year to the Sea will be necessary to implement a successful restoration plan. Balancing the mandates of the QSA with the parameters needed for an effective restoration plan will be critical. The following section of this paper will discuss the parameters of the Salton Sea Authority's restoration plan.

Rising salinity in the Sea is a major concern. The Sea's salinity is currently at about 46 parts per thousand (ppt) and rising by approximately 0.4 ppt annually. About 4 million tons of salt accumulate in the Sea every year. Rising salinity levels cause physiological stress on aquatic species. Species are more susceptible to physical factors like limited oxygen and extreme temperatures and biological factors such as disease and predation. Certain reproductive functions can also be impaired. Any one of these effects could result in the loss of a species (SSSS 1998).

Salts are formed through reactions between cations and anions. An abundance of these different elements and compounds will result in saltier water. Salts found in the Sea include sodium chloride, salts made from sulfate combining with magnesium, calcium or potassium and calcite. Calcite is formed by the combination of calcium and bicarbonate. Chloride levels in the Whitewater River are moderate at about 200 mg/l. However, chloride levels in the New River can exceed 1000 mg/l. This exceeds the EPA's aquatic life use standard of 700 mg/l for freshwater systems. Sulfate levels are also a concern in the Alamo and New Rivers. The EPA standard is 500 mg/l and sulfate was measured at over 700mg/l in both of those rivers. Calcium and magnesium are at fairly normal levels in the three rivers but levels of sodium are of concern in the Alamo and New rivers. Aquatic life can begin to suffer when sodium levels exceed 250 mg/l. Sodium levels in the Alamo River are over 400 mg/l and the New River is in excess of 600 mg/l.

Hardness in aquatic systems measures salts with positive charges like calcium, magnesium and sodium. The U.S. Department of the Interior says that water with levels of hardness above 180 mg/l is very hard. All of the measurements in the three rivers greatly exceed this level including measurements from the New River that are over 800 mg/l. This demonstrates the ability of these water sources to contribute to the tremendous salt load on the Sea. Alkalinity measures the concentration of alkaline compounds in water such as bicarbonate. Desired levels of alkalinity are between 100 and 200 mg/l. The New River is the only water source exceeding this threshold showing readings of up to 260 mg/l. The buffering capacity of a stream is directly related to its level of alkalinity. Buffering capacity allows water to neutralize acidic pollution and resist changes in pH. The healthy level of alkalinity in the rivers helps to maintain desired pH levels. Optimal

pH levels for most aquatic life range from 6.5 to 8.2. Average pH levels for all three rivers are around 7.7.

Measuring conductivity is a way to measure water's carrying capacity for electric current. It is also a way to measure the amount of dissolved salts in the water.

Conductivity measures the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron and aluminum.

Conductivity is measured in micromhos per centimeter (umhos/cm). This unit measures the flow of electricity in water. Generally, streams supporting healthy fish populations range between 150-500 umhos/cm and highly polluted industrial water can reach levels of 10,000 umhos/cm (Murdoch 2001). All three rivers exceed levels that contribute to a healthy environment for fish. The Whitewater River measures about 1800 umhos/cm, the Alamo River is about 2700 umhos/cm and the New River shows readings of up to 4500 umhos/cm. These measurements coincide with the high levels of Total Dissolved Solids that were found in the rivers. These data reinforce the fact that the inflows to the Sea are salt rich and continually elevating salinity levels in the Sea. Data like these should demonstrate a sense of urgency to commence restoration activities.

Dissolved Oxygen (DO) is the amount of oxygen that is available to aquatic organisms. DO levels between 6 and 8 mg/l are considered adequate for most aquatic life. DO levels above 8 mg/l are found in extremely healthy streams whereas levels below 5 can begin to stress most fish. DO levels in all three rivers were pretty good. The lowest reading was in the New River at 5.3 mg/l, the Whitewater River showed an 8.5mg/l measurement and the Alamo River had a reading of 9.4 mg/l. As I mentioned before, these levels can change drastically in the more stagnant, stratified layers of the Sea.

Biochemical Oxygen Demand (BOD) shows the amount of oxygen that is being consumed by bacteria during the decomposition of organic material like algae.

Unpolluted, natural waters should have a BOD of 5 mg/l or less while raw sewage may have BOD levels ranging from 150-300 mg/l (Murdoch 2001). All three rivers showed BOD levels above 15 mg/l. This demonstrates that the processes creating anoxic conditions in the Sea, as a result of decomposing algal blooms, are beginning to occur before the water reaches the Sea.

External loading of nutrients, particularly phosphorous, to the Sea from agricultural discharges and from municipal and industrial effluent is responsible for the eutrophication of the Sea (Holdren 2000). It is estimated that industrially fertilized crops only absorb one third to one half of the nitrogen that is applied as fertilizer (Tilman 1998). The remaining nitrogen is washed into the rivers that feed the Sea. Nutrient loading of the inflows to the Sea are a serious concern. Gigantic algal blooms created by large quantities of available nutrients in the Sea decompose and deplete DO resulting in massive fish die-offs. Any restoration activities for the Sea should pay close attention to the nutrient levels of the water entering it.

The data indicate that all of the nutrient levels for the rivers are very high. Often times limits for nutrients containing nitrogen are set in terms of micrograms per liter. The results for the Sea's inflows are in multiple milligrams per liter. That is a difference of three orders of magnitude. The EPA's reference criteria for nitrate in streams and rivers are 0.067 mg/l and the Whitewater River shows a reading of over 13 mg/l. Another EPA recommendation for kjeldahl nitrogen is 0.44 mg/l and all of the measurements for the New River are over 5 mg/l. Recommended levels of ammonia depend on a lot of different

factors making specific recommended levels for water quality hard to come by. However, ammonia is of particular concern because it can be toxic to fish under certain conditions. Anoxic conditions created in the Sea as a result of algal decomposition have produced lethal levels of ammonia and hydrogen sulfide. When strong desert winds mix the thermally stratified layers in the Sea these poisons cause massive fish die-offs. These rivers are far from pristine and the Regional Water Quality Control Board is still trying to figure out desired levels of nutrients for them. At this point any decrease in nutrient levels would be considered a success.

Scientists agree that the hyper-eutrophic conditions at the Salton Sea are controlled or limited by phosphorous, specifically orthophosphate phosphorous because that form of phosphorous is the one that is most readily available to aquatic plants (Holdren 2000). Very small amounts of orthophosphate, even as low as 0.01 mg/l, can have a significant impact on plant growth in a stream (Murdoch 2001). The Whitewater River showed measurements in excess of 1 mg/l and the other two rivers were approaching 1 mg/l of orthophosphate phosphorous. Just as we saw with the nitrogen containing compounds, compounds containing phosphorous are also very high. The nutrient loading of the Salton Sea will be a challenge for scientists and restoration advocates for years to come.

Some water quality concerns that are not represented by these data relate to pesticides and selenium. The organophosphate pesticides diazinon, chlorpyrifos, malathion and carbofuran were present at toxic levels in the Alamo River and the Alamo River delta within the Salton Sea (RWQCB 2003). Studies conducted by the U.S. Fish and Wildlife Service detected organochlorine pesticides including DDT at levels of

concern (RWQCB 2003). These pesticides were attached to sediments in the rivers and the Sea. Selenium is present in the Alamo River at approximately 7-8 parts per billion (ppb), a level that exceeds the State's water quality objective of 5 ppb (RWQCB 2003). Selenium is of concern because it has also been detected at substantial levels in fish that were caught in the Sea. This information and the data presented in this section demonstrate serious water quality issues with the inflows to the Sea. These conditions are not improving and measures to deal with them should be taken immediately.

**Table 1**

**Salton Sea Inflows 2004**

	<b>Whitewater River</b>	<b>Alamo River</b>	<b>New River</b>	<b>Ag. Drains*</b>	<b>Ground Water*</b>	<b>Rain*</b>
January	4,511	39,227	26,385	8,667	4,333	3,250
February	4,693	41,886	31,476	8,667	4,333	3,250
March	4,338	52,770	40,449	8,667	4,333	3,250
April	3,808	64,973	40,164	8,667	4,333	3,250
May	4,173	61,983	35,004	8,667	4,333	3,250
June	3,646	54,004	34,891	8,667	4,333	3,250
July	3,316	54,390	34,129	8,667	4,333	3,250
August	3,937	51,567	32,529	8,667	4,333	3,250
September	3,389	50,367	30,488	8,667	4,333	3,250
October	3,775	54,580	33,250	8,667	4,333	3,250
November	3,765	45,033	28,296	8,667	4,333	3,250
December	3,927	39,334	20,102	8,667	4,333	3,250
<b>Total</b>	<b>47,277</b>	<b>610,114</b>	<b>387,163</b>	<b>104,004</b>	<b>51,996</b>	<b>39,000</b>

**Total Salton Sea 2004 Inflows: 1,239,554**

All values are in acre-feet

\*Numbers generated from annual historical averages

**Source:**

Coachella Valley Water District

Imperial Irrigation District

**Table 2****Whitewater River Data**

	<b>Whitewater River 3/24/2003</b>	<b>Whitewater River 5/20/2004</b>	<b>Whitewater River 11/18/2004</b>	<b>Whitewater River 2/15/2005</b>
<b>Cations</b>				
Calcium	98	120	110	100
Magnesium	27	33	30	NA
Sodium	NA	260	240	NA
Hardness	360	430	390	438
<b>Anions</b>				
Bicarbonate	230	250	200	180
Sulfate	420	410	400	592
Chloride	NA	220	170	NA
Alkalinity	190	200	170	220
<b>Nutrients</b>				
Ammonia	1.6	0.97	NA	3.39
Nitrite	0.58	0.72	0.64	0.6
Kjeldahl-N	3.3	2.4	1.4	3
Orthophosphate-P	0.86	0.75	1.2	1
Total Phosphorous	1.3	0.99	1.6	0.99
Nitrate	11	NA	NA	13.2
<b>Other</b>				
pH	7.5	7.4	7.6	7.8
Conductance*	1655	2000	1800	2116
Total Dissolved Solids	NA	1300	1100	NA
BOD	13	9	14	17.1
Dissolved Oxygen	5.5	NA	NA	8.5
Temp.**	22.2	NA	NA	18.3
Total Suspended Solids	45	80	90	265

All values in mg/l

\*Conductance units are umhos/cm

\*\*Temp. units are degrees C

**Source:**

Coachella Valley Water District  
Regional Water Quality Control Board

**Table 3****New River Data**

	<b>New River 3/24/2003</b>	<b>New River 5/18/2004</b>	<b>New River 1/26/2005</b>	<b>New River 4/19/2005</b>
<b>Cations</b>				
Calcium	190	117	180	180
Magnesium	90	65	95	95
Sodium	578	422	649	639
Hardness	850	640	863	803
<b>Anions</b>				
Bicarbonate	300	290	256	236
Sulfate	720	610	769	575
Chloride	759	592	1088	1028
Alkalinity	250	230	234	260
<b>Nutrients</b>				
Ammonia	3.6	2	3.9	3.4
Nitrite	0.49	1.8	0.1	0.1
Kjeldahl-N	6.5	5.1	5.5	6
Orthophosphate-P	0.68	0.67	0.3	0.79
Total Phosphorous	1.6	0.95	1.36	6.2
Nitrate	3.2	2	9	7.5
<b>Other</b>				
pH	7.6	7.5	8.3	7.8
Conductance*	3538	3420	4500	3885
Total Dissolved Solids	2524	2002	3073	2284
BOD	18	6.8	15.3	13.4
Dissolved Oxygen	6.4	5.3	7	5.4
Temp.**	20.5	24	17.5	21
Total Suspended Solids	260	270	258	NA

All values in mg/l

\*Conductance units are umhos/cm

\*\*Temp. units are degrees C

**Source:**

Imperial Irrigation District

Regional Water Quality Control Board



**Table 4**

**Alamo River Data**

	<b>Alamo River 3/24/2003</b>	<b>Alamo River 5/18/2004</b>	<b>Alamo River 1/26/2005</b>	<b>Alamo River 4/12/2005</b>
<b>Cations</b>				
Calcium	160	137	134	165
Magnesium	76	80	90	105
Sodium	287	334	494	492
Hardness	710	690	729	715
<b>Anions</b>				
Bicarbonate	250	250	210	209
Sulfate	630	660	657	742
Chloride	372	425	592	635
Alkalinity	200	210	190	202
<b>Nutrients</b>				
Ammonia	1.3	1.1	0.25	1.7
Nitrite	0.54	1.6	0.1	0.6
Kjeldahl-N	3.2	3.3	0.2	3.19
Orthophosphate-P	0.42	0.43	0.3	0.4
Total Phosphorous	0.99	0.6	0.32	0.81
Nitrate	4.8	4	7	6
<b>Other</b>				
pH	7.7	7.6	7.9	7.7
Conductance*	2270	2963	2949	2831
Total Dissolved Solids	2044	1854	2352	1813
BOD	12	4.6	6.2	15.6
Dissolved Oxygen	7.7	6.4	9.4	5.7
Temp.**	19.4	24	16.7	20
Total Suspended Solids	360	240	234	NA

All values in mg/l

\*Conductance units are umhos/cm

\*\*Temp. units are degrees C

**Source:**

Imperial Irrigation District

Regional Water Quality Control Board

## **Restoration Plan**

The Salton Sea Authority (SSA) and Tetra Tech Inc. created the restoration plan that is described in this section. Tetra Tech is a worldwide, private environmental engineering firm with an office located in Palm Desert, California. The information in this section is derived from documents created by Tetra Tech and the Salton Sea Authority. This innovative plan combines the SSA's vast scientific resources and local knowledge with Tetra Tech's expertise in environmental engineering. Over the years many different restoration plans have been proposed for the Sea. Some of them included pumping water from the Sea to the Gulf of California or creating huge, local evaporation ponds as a means to harvest salt. However, after extensive evaluation the SSA/Tetra Tech plan has become the preferred restoration alternative for the SSA.

The main objectives for the restoration plan were inspired by the goals outlined in the Salton Sea Reclamation Act of 1998. The purpose of the plan is to:

- Preserve the Sea as an agricultural drainage basin
- Maintain a large marine lake with stable elevation
- Improve water quality (salinity, nutrients, toxics)
- Maintain and improve wildlife habitat
- Respond to inflow changes
- Increase recreational and economic potential
- Address air quality concerns

A very important feature of this plan that most other plans leave out is increasing the economic viability of the area. The plan incorporates and encourages the economic growth of local communities. I will address this component of the plan later. First we will look at the physical design of the plan.

The Sea will be divided by a rock-filled, concrete causeway or dike. This will create a 135 square mile marine lake at the North end of the Sea. The south end of the Sea will contain a 35 square mile lake, saltwater marsh habitat zone, a water storage reservoir for the Imperial Irrigation District and a large zone in the middle to serve as a salt sink. See Figure 3 at the end of this section for clarification. The division of the Sea will allow one portion to act as a receptor for the discharge of the other. By circulating the water between the north and the south sections salinity levels will be controlled in the north lake while they are allowed to accumulate in the south end's salt sink.

To generate the circulation of water the New and Alamo rivers will be redirected to flow into the south lake. Eventually this water will flow along the west shore of the Sea in a constructed channel that passes through the mid-sea barrier into the north lake. At the other end of the causeway on the east shore of the Sea, water will leave the north lake by flowing into another constructed channel. This channel will allow some of the water to flow into a saltwater marsh habitat eventually ending up in the shallow salt sink zone. The majority of the water in this channel will go through a water treatment plant. Salt sludge from the plant will also flow to the salt sink zone. The rest of the treated water will continue to flow south and eventually re-enter the system through pumps that discharge into the south lake.

700,000 acre-feet of water per year are needed to make this plan work. The north lake requires 500,000 acre-feet and the south lake and saltwater marsh areas require an additional 200,000 acre-feet annually. These flows will maintain a target elevation for the north lake of 235 feet below sea level. This level will be high enough so that gravity will allow water to flow from the north lake to the channel on the east shore. It will also allow enough elevation change so that the Alamo and New rivers will be able to flow into the south end of the system. Furthermore, a sea level of -235 will keep the shores of the Sea submerged to eliminate the potential for fugitive dust problems. If this level is maintained by flows totaling 700,000 acre-feet per year and construction of the project begins in 2006 the target salinity of 35 ppt could be achieved by 2013.

Nutrients would be removed in this system in a number of different ways. Another part of this plan is to construct additional wetland areas along the New and Alamo rivers in reaches in Imperial County before they meet the Sea. The wetlands natural filtration process will help to reduce nutrients. A similar process will occur in the constructed saltwater marsh habitat in the south end of the system. The most effective measure will be the treatment plant located on the canal along the east shore. The plant will be able to remove large amounts of algae and nutrients before water is released back into the system.

Salinity will also be greatly reduced by this system. The channels that will be constructed on either side of the Sea will allow the water in the system to be circulated instead of being stagnant. The channel on the west shore will bring river water and re-circulated, treated water to the north lake. The channel on the east shore will release some salty water into the saltwater marsh habitat and the rest will flow to the treatment plant.

The saltwater sludge effluent from the plant will flow through the saltwater marsh into the salt sink. In the salt sink zone much of the water will evaporate leaving behind large deposits of salt. Furthermore, the treated water will continue to circulate through the system diluting the salinity of the north lake.

Selenium and harmful compounds from pesticides that have accumulated in the sediments of the Sea will be controlled as well. Maintaining the elevation of the north and south lakes will control the movement of these sediments. The saltwater marsh areas will also prevent the sediments from blowing around. The salt sink zone will have some areas of shallow water and thick crusty layers of salt will cover the rest of the surface. The plan has also set aside money for various selenium removal projects. There is even the possibility of building a selenium removal plant on the Alamo River.

There are some existing communities that are located on the shores of what will be the north lake. The cities of North Shore, Desert Shores and Salton City will benefit tremendously from the restoration plan. Existing recreational infrastructure, including the State Park, could come back to life giving these communities a welcome economic boost. The Torres Martinez Indians own a substantial amount of land on the northwest shore. The Indians have plans to build a resort, marina and some housing if the restoration plan is implemented. A restored Sea would invite a tremendous amount of commercial, recreational and residential economic development for the surrounding areas. It makes perfect sense if you look at the projected population growth for California, especially when you take into consideration the astronomical real estate prices of the already developed areas in the state.

This plan will cost between 650 and 730 million dollars. An additional 10 million dollars a year will be needed to maintain and operate the channels, causeway and treatment plant. Construction of additional shallow water wildlife habitat is also accounted for in the annual operating costs. The SSA has designed a plan that will generate money for the project locally. This plan does not depend on large handouts from the federal government. That is very unusual for a project of this magnitude. The SSA has developed an Infrastructure Finance District (IFD) that encompasses a 425 square mile region surrounding the Sea. Working with various consultants the SSA has determined that the region could see one million new residents by 2030. These one million new residents would live within the IFD. Bonds created from this tremendous new tax base would generate money for the restoration plan. The increase in property taxes from the newly developed area will support the sale of local, tax-increment, municipal, bonds. Based on a 30-year build-out for new development and assuming a 35-year bond term with 6% interest, bond financing of 400 to 600 million dollars is possible. Assessment districts will be set up to finance the annual maintenance and operation of the new system. This is another municipal financing tool that generates money by taxing residents who benefit from the project. Generating funds like this locally while developing the area is a major win-win situation for the region.

Another upside to this development scenario is that there is an energy source in the area to provide power for the new homes. There is an existing geothermal energy plant adjacent to the southern end of the Sea. The new restoration plan would expose some previously submerged areas that are a source of geothermal energy. This would allow further development of the geothermal energy sources in the area.

Additional funds for the project may be available if certain legislation is passed. These funds would include money from the sale of water mandated by the QSA. The QSA has designated 300 million dollars from the sale of water to go toward the restoration of the Salton Sea. There are also some funds available from Prop. 50. Through the sale of California State Bonds, Prop. 50 generated hundreds of millions of dollars for water projects in California. The sale of BLM land could be another mechanism for generating funds for this project.

The SSA has come up with a great plan and a way to pay for it. However, the SSA still has some obstacles to overcome before the plan gets the green light. The following sections will address some of the challenges that the SSA has to deal with while it is pursuing this progressive restoration plan.

Refer to Figure 3 on the following page for a diagram of the SSA's preferred restoration plan.







## **Problems With The QSA & DWR**

The legislation in the Quantitative Settlement Agreement (QSA) has some major problems despite the fact that it was touted as very progressive environmental legislation. The QSA does set aside money for the restoration of the Sea, but the way that it is generated and the way that it will be spent is troubling. Restoration money for the Sea will come from the sale of water from the Imperial Irrigation District to various municipalities. This is a good way to generate money, however there need to be limits on how much water can be sold. After all, taking water away from the Sea is what will kill it. Currently the Sea receives 1.3 million acre-feet per year. The Department of Water Resources (DWR) is allowed to sell up to 1.6 million acre-feet per year to generate money for restoration. Obviously this would be a problem. There is no set amount of water that is to be dedicated to sustain the Sea in the QSA.

The QSA put the State of California, acting through the DWR, in control of the Sea's restoration. It also makes them liable for problems that occur at the Sea. The problem here is that the DWR operates out of Sacramento and is far removed from the Sea and it's surrounding communities. The DWR is not expressing any sense of urgency for the implementation of a restoration plan. They have been tasked with the restoration process, are supposedly familiar with the science and issues of the Sea and they have the money to proceed with a plan but they are not doing anything. The QSA mandates that they choose a preferred restoration plan by the end of 2006. The SSA's plan is one of the plans on the table. The current plan that the DWR is favoring is the "Evolving Sea Plan". This "plan" requires no action. The DWR is focusing on spending restoration funds on mitigation. One would think that the State would have learned from their mistakes at

Owens Lake. The mitigation costs there quickly rose into the hundreds of millions. Furthermore, when the QSA restoration funds are exhausted the state is responsible for coming up with the extra money to mitigate the problems at the Sea.

Currently the DWR is squandering 20 million dollars of Prop.50 funds on redundant science projects. They are conducting studies that have all been done by the SSA, EPA, Bureau of Reclamation and various universities over the past two decades. Some other plans that the DWR has chosen to evaluate directly contradict what many previous studies have proven. One example is the fact that they are entertaining restoration plans with inflows of less than 500,000 acre-feet. The Bureau of Reclamation, and others, have done environmental impact surveys that all state an effective restoration plan will need between 700,000 and 900,000 acre-feet to work. In addition the DWR has greatly downplayed the concerns surrounding air quality. In many cases they choose to ignore the issue all together.

The State's plan specifically excludes economic development and recreational opportunities as project purposes. This directly contradicts the goals set out by the Salton Sea Reclamation Act of 1998. There are other aspects of the QSA that negatively impact local economies. Fallowing of land is an option for water conservation. This will take away jobs from local people and cut into the regions primary source of revenue.

The State is relying upon the federal government to step in and provide a substantial amount of funding for the Sea. By waiting around and squandering existing funds on costly mitigation processes the State will leave the federal government with a huge financial burden. The State's process for the Sea's restoration has become bogged down with government red tape, competing special interests, incompetence and a general

lack of desire to restore the Sea. The money and development that is involved with the water transfers have made the process very political, not to mention that the amount of money to be made on the transfers is not specific. When the law OK's the sale of up to 1.6 million acre-feet that is probably how much will be sold. There are a lot of powerful entities involved that would much rather see the Sea die so they can profit and advance their own agendas. However, all is not lost yet. The SSA is working on changing some of these problems by means of new legislation and policy contracts with the Imperial Irrigation District.

## **Future Legislation & Contracts**

The greatest hope for the Salton Sea Authority (SSA) and their preferred restoration alternative is the creation and passage of a new bill in the State legislature. The SSA is working with Senator Denise Duchenev to sponsor a new bill for the Salton Sea Local Control Act. Provided that the SSA comes up with 500 million dollars in non-state and non-federal funding the bill would include the following:

- SSA designated as implementing agency for Salton Sea restoration project
- SSA authorized to construct project of its choice at its cost
- SSA is given control over \$300 million in local water transfer restoration funds and remaining Salton Sea Prop. 50 funds
- Contract with Imperial Irrigation District for 700,000 acre-feet of water a year dedicated to the Sea
- SSA will reduce the State's liability under the QSA by funding \$25 million to existing \$133 million in environmental impairment account

- DWR limited to spending \$10 million in Prop. 50 funds on current studies
- If required SSA will indemnify State of debts, liabilities and obligations to the Sea

Although the contract with the Imperial Irrigation District (IID) is a component of the bill, the SSA is currently negotiating with them to dedicate 700,000 acre-feet per year to the Sea. The IID is a member agency of the SSA and they do have an interest in restoring the Sea. The adoption and passage of the Salton Sea Local Control Act and a secured contract with the IID for dedicated water would save the Sea.

## **Recommendations**

I recommend that legislators adopt and pass the Salton Sea Local Control Act as soon as possible. The SSA is the premiere agency that has worked with scientists and local communities in assessing the situation at the Sea from the beginning. They have a genuine interest in restoring the Sea while meeting the needs of the other agencies and communities involved. The conditions at the Sea are no longer a mystery. The science has been done and now it is time to act. It is important to implement a restoration plan immediately. The Sea's conditions get worse every day and ecological collapse is imminent. The SSA has the money for the plan and is willing to take the burden of liability off the State. Putting the SSA in control will eliminate the bureaucracy and red tape created by State agencies that are slowing down the restoration process.

It is important to support the SSA in their efforts to lobby local and State officials to urge them to pass the Salton Sea Local Control Act. Monetary contributions can be made to the SSA's political lobbying fund. People concerned with the Sea should also

write a letter to Senator Ducheny encouraging her to support this bill. Send your letters to:

Senator Denise Ducheny  
State Capitol, Room 4081  
Sacramento, CA 95814

In order to create awareness for this situation I think it is important to try and leverage the member base of sympathetic organizations. Organizations like the Audubon Society and Defenders of Wildlife should engage in letter writing campaigns to support the SSA's plan. If possible television ads should be created to educate local communities in Riverside and Imperial counties to heighten peoples awareness of the perils they could face if the Sea is left to die. Air quality and public health should be emphasized in the ads. This type of awareness would help to combat the isolation factor of the Sea. Due to the Sea's remote location very few people are aware of the problems with it and what they could mean to them.

Another great tactic to bring attention to the Sea, which the SSA is doing, is to leverage the potential for economic growth in the area. When developers realize the potential to create vibrant communities around the Sea it will bring parties with power and political influence into the equation. California's growing population needs to go somewhere and building on already existing communities surrounding the Sea makes a lot of sense.

Regardless of what restoration plan is put into place it is critical to limit nutrient levels in the Sea. Continuing to build and conserve wetlands along the New and Alamo rivers should be a high priority. Some of the money designated for restoration should be spent on a treatment facility for the Alamo River because it contributes the largest

amount of water to the Sea. A treatment facility would greatly decrease nutrient levels for the Sea. If a treatment facility is not possible it will be important to adopt methods like adding lime and other compounds to the water that will neutralize phosphorous and orthophosphates. Experts in these fields should be employed to administer these solutions. I recommend that the Regional Water Quality Board continue with their nutrient TMDL program. Given the unique conditions in the rivers I would encourage them to make particularly stringent standards for nutrients. Along with the TMDL program I think the water board should conduct more frequent audits on farmers to make sure that they are complying with Best Management Practices (BMPs). Furthermore, the water board should establish a stronger relationship with the Farm Bureau to help educate farmers about land use practices so they can more easily comply with BMPs. After all, the farming industry has created the majority of the water quality problems with the Sea.

Air quality issues will be a major threat to public health if the level of the Sea drops significantly. This should be a major focus when evaluating the future conditions of the Sea. Additional testing and modeling should be done to demonstrate the similarities of the Salton Sea and Owens Lake. Owens Lake provides an extremely valuable lesson for potential air quality problems. Restoration advocates should continue to leverage the power of enforcing federal air quality standards that are already being exceeded in Imperial and Riverside counties. Drawing attention to Owens Lake through the use of additional studies and modeling should raise concerns for any rational people trying to address air quality problems.

It would be useful to get farmers more involved in the fight for the restoration of the Sea. Farmers should organize and raise their concerns over the loss of water that will

occur if the QSA goes unchecked. Water transfers and the fallowing of fields will surely hurt the farm economy. Farmer's livelihoods are directly tied to the livelihood of the Sea. Farmers should form new groups or leverage existing groups and organizations that they are involved in to draw attention to the issues that will affect them and the Sea.

At this point the fate of the Salton Sea is in the hands of the legislature and the DWR. The best case scenario for the Sea is if the legislature takes the fate of the Sea out of the hands of the DWR and puts it into the hands of the SSA by adopting and passing the Salton Sea Local Control Act. I believe that the passage of this Act and a contract with the Imperial Irrigation District for dedicated flows to the Sea will save the Sea. A lot of work has been done up to this point and a solution is close at hand. The fact that a solution is so close at hand is bringing out a lot of resistance from people who would profit from the death of the Sea. The high dollar values and political ties that are involved have created some formidable adversaries like the Metropolitan Water District that is interested in further developing communities near the coast. However, the SSA's plan is very sound and more importantly, paid for. The SSA is also bringing some powerful interests to the table. Hopefully the entities interested in the restoration of the Sea and its surrounding communities will outweigh the interests of State agencies and entities trying to further develop the coastal regions of the State.

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